§44. Three-Dimensional Particle-in-Cell Simulation with Monte Carlo Collision

Ishiguro, S.

There is a growing interest in investigation of the kinetic effects of scrape off layer plasmas in magnetic fusion devices. For example, charged particle dynamics not only along a magnetic field but also across a magnetic field plays an important role in a blob transport across a magnetic field in a scrape off layer[1-5]. Plasma behavior in the helical diverter in Large Helical Device (LHD) also may cast an importance of kinetic treatments in three dimensional configuration. Particle-in-Cell (PIC) simulation method is one of the candidates for kinetic treatment. Unfortunately, usual PIC simulation cannot treat a whole system of SOL because of large spatiotemporal scale in SOL plasma dynamics. However, some important physics, such as self-consistent potential structure formation and transport, can be presented by using a system with reduced space and time scale. In addition, PIC simulation takes an important part in multi-layer SOL simulation in which fluid type simulation and kinetic type simulation may be self-consistently connected. With these situations in mind we have been developing three dimensional PIC simulation code for investigation of dynamic plasma behavior in a SOL. This code includes collisions between charged particles and neutral particles. The collision processes such as elastic, excitation, and ionization collisions are treated by using collision cross section table and random numbers. As for this treatment it is according to the PIC-MCC model[6-7]. Three dimensional real space and three dimensional velocity space are taken into account. At the same time, the structure which has complicated form is taken in to system. An impinging charged particle into the wall and the structure is removed from the system and the charge remains the striking point. The structure and wall are assumed electrically floated and absorbed charge and plasma particle charge are self-consistently treated. Figure 1 shows the flow chart of the simulation. Initially, the geometric form of a system, form of structures, initial plasma parameters and external circuit parameters are set. The time step loop consists of accumulation of electric charge from particle position, solving Poisson Equation, accelerating particles, moving particles, handling particles which impinging into the wall or the structures, repacking particle information, handling collisions between charged particles and neutrals. These procedures are repeated.

Repacking of particle information as well as handling of collision process are optimized for SX one node system. Extension for multi-nodes system will be performed.

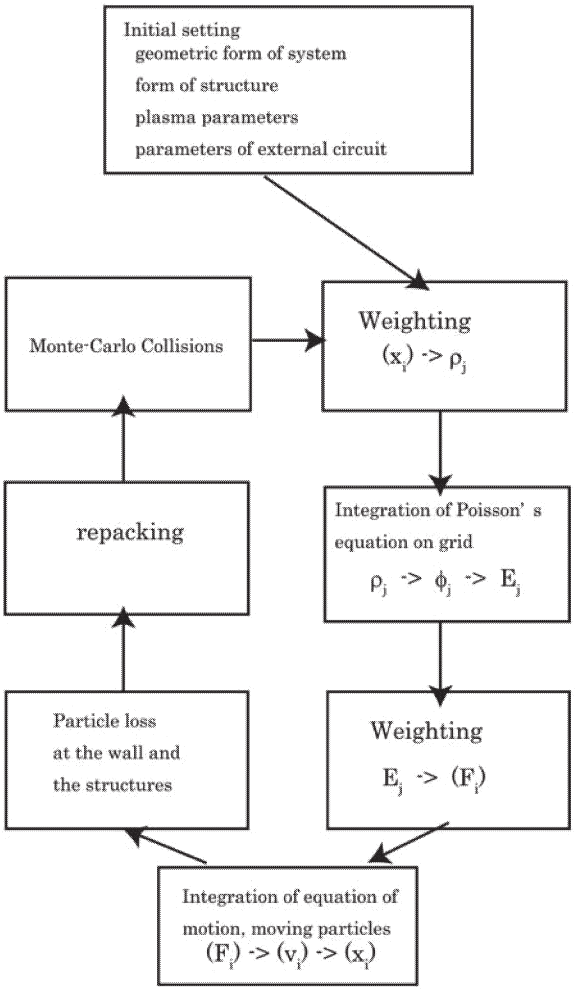

Fig. 1. Flow Chart for an PIC scheme with the addition of the collision handler.

References

[1] Umansky, M et al.: Phys. Plasmas **5**, (1998) 3373.
[2] Schneider, R. et al., in: 17th International Conference on Plasma Physics and Controlled Fusion Research, Yokohama, Japan, 19-24 October, 1998, paper FI-CN-69/THP2/05.
[3] Lipschultz, B. et al. in: 18th IAEA Fusion Energy Conference, Sorrento, Italy, 4-10 October, 2000, paper IAEA-CN-77/EX5/6.
[4] Zweben, S. J. et al.: Nucl. Fusion **44**, (2004)134.
[5] Krasheninnikov, S. I. :Phys. Lett. A **283**, (2001) 368.
[6] Vahedi, V. and Surendra, M: Comp. Phys. Comm. **87**, (1995) 179.
[7] Nambu, K:Jpn J. Appl. Phys. **33**, (1994) 4752.